MethodSCRIPT SDK Example - C

PalmSens
Compact Electrochemical Interfaces

Last revision: August 13, 2020

www.palmsens.com

1 Contents

The example *MethodSCRIPTExample.c* found in the */MethodSCRIPTExample_C* folder demonstrates basic communication with the EmStat Pico. The example allows the user to start measurements on the EmStat Pico from a Windows or Linux PC using a simple C program which makes use of the MethodSCRIPT SDK (C libraries).

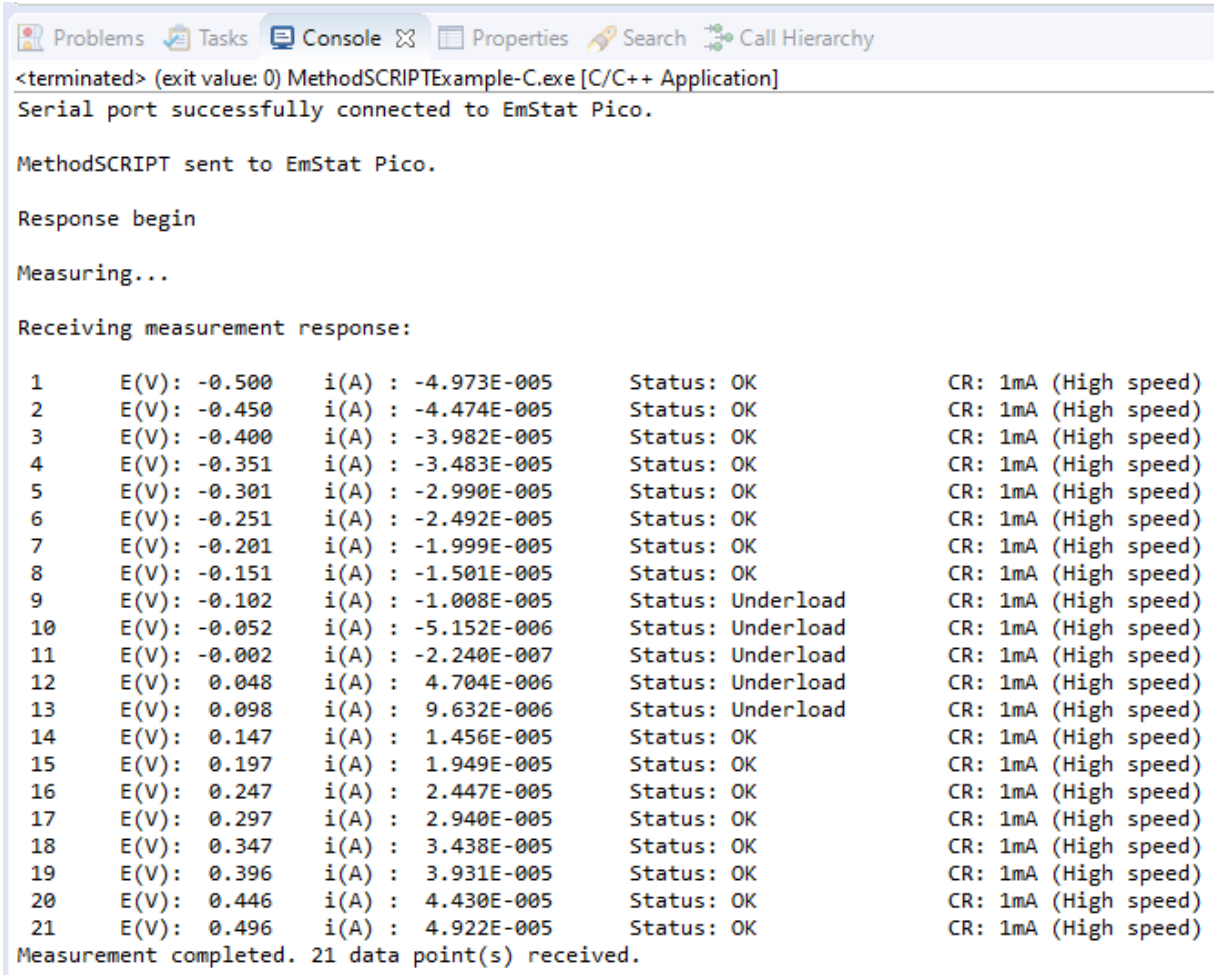
2 Basic Console Example (MethodSCRIPTExample.c)

This example demonstrates how to implement serial communication with the EmStat Pico to

- Establish a connection with the device
- Write a MethodSCRIPT to the device
- Read and parse the measurement data packages from the device
- Print the parsed data to the console
- Write the parsed data to a CSV file

This does not include error handling, method validation etc. All packages within a MethodSCRIPT measurement loop are assumed to have the same format as the first package in that loop.
This example is build using Eclipse CDK and the MinGW toolset.

The console output of one of the examples is shown below.



3 Communications

The *MSComm.c* from the MethodSCRIPT SDK (C libraries) acts as the communication object to read from and write to the EmStat Pico. The specific implementation of the serial port interface depends on the Operating System.

3.1 Serial port (Windows PC)

The functions in the code snippet below are the necessary read/write functions defined in the C example. WriteToDevice writes a char to the EmStat Pico and ReadFromDevice returns the first byte from the read buffer as soon as there is data available in the buffer.

```
int WriteToDevice(char c)
{
	char writeChar[2] = {c,'\0'};
	if (WriteFile(hCom, writeChar, 1, &dwBytesWritten, NULL))
	{
		return 1;
	}
	return 0;
}

int ReadFromDevice()
{
	char tempChar;			// Temporary character used for reading
	DWORD noBytesRead;
	ReadFile(hCom,			// Handle of the Serial port
		&tempChar,		// Temporary character
		sizeof(tempChar), // Size of TempChar
		&noBytesRead,	// Number of bytes read
		NULL);
	//Check for timeout
	if(noBytesRead != sizeof(tempChar))
		return -1;		//Return -1 on timeout
	return (int)tempChar;
}
```

The read/write functions are required to initiate the *MSComm* communication library.

```
MSComm msComm;
RetCode code = MSCommInit(&msComm, &WriteToDevice, &ReadFromDevice);
```

The following code snippet shows how to open a serial com port using the Windows API. In order to use the Windows API for serial communication, the windows.h header has to be included in the C program's header file as shown below.

```
#include <windows.h>
```

A valid handle to the port to which the EmStat Pico is connected is necessary for the read/write functions in the *MSComm* library. The code below can be used to open the com port connected to the device.

```
const char* PORT_NAME = "\\\\.\\COM37";

HANDLE hCom;
// must be opened with exclusive-access
hCom = CreateFile(PORT_NAME, GENERIC_READ | GENERIC_WRITE, 0,
                  NULL,              // no security attributes
                  OPEN_EXISTING,     // must use OPEN_EXISTING
                  0,                 // not overlapped I/O
                  NULL               // NULL for comm devices
  );
```

The name of the com port connected to the device can be found in the Windows ‘Device Manager’ as displayed below.

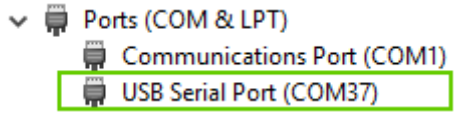


Fig: Available com ports in Device Manager

Once a valid handle is created, settings like baud rate (230400), databits (8), parity (None) and stopbits (1) has to be set using the Device Control Block (DCB) object.

3.2 Serial port (Linux PC)

Before opening a serial port the baud rate and port name has to be configured using the *BAUD_RATE* and *SERIAL_PORT_NAME defines* located in “MethodSCRIPTExample.h”. The serial port of the Pico can be obtained by issuing the following command in the terminal:

```
dmesg | grep FTDI
```

It is usually called “ttyUSBx” where x is a number.

The example implements the serial communication interface in the file “SerialPort_Linux.c”. This file implement the same C-interface to provide a layer of abstraction. On Linux the serial port can be accessed using the TERMIOS library which handles the interface as if it is a file and provides open, read, write and close functions. Besides that the port has to be configured using cflags. Note: only baudrates of the type speed_t are supported. The configuration used in the example is as follows:

```
// Set baudrate for both input and output
speed_t baud_config = baud_to_termios(BAUD_RATE);
cfsetispeed(&config, baud_config);
cfsetospeed(&config, baud_config);

// Input flags - Turn off input processing and flow control
config.c_iflag &= ~(IXON | IXOFF | IXANY);

// Local mode flags - disable echo and put the interface in non-canonical
mode
config.c_lflag &= ~(ICANON | ECHO | ECHOE | ISIG);

// Output flags - Turn off output processing
config.c_oflag &= ~OPOST;

// Control mode flags - Turn off output processing and act as null-modem
config.c_cflag &= ~(PARENB | CSTOPB | CSIZE | CRTSCTS);
config.c_cflag |= CS8 |CREAD | CLOCAL;
```

This configuration is set in the OpenSerialPort function. The function prototypes for the Windows/Linux C examples are shown below.

```
/// Opens the serial port to which the EmStat Pico is connected.
/// Returns: 1 on successful connection, 0 in case of failure.
int OpenSerialPort();

/// Writes the input character to the device
/// Returns: 1 if data is written successfully, 0 in case of failure.
int WriteToDevice(char c);

/// Reads a character read from the EmStat Pico
/// Returns: -1 on failure or the value of the received byte on success
int ReadFromDevice();

/// Closes the serial port
/// Returns: 1 if closed successfully, 0 in case of failure.
int CloseSerialPort();
```

The ReadFromDevice / WriteToDevice functions are required to initiate the *MSComm* communication library and have to be passed to the init function.

```
MSComm msComm;
RetCode code = MSCommInit(&msComm, &WriteToDevice, &ReadFromDevice);
```

3.3 Sending the MethodSCRIPT

The MethodSCRIPT can be read from a txt file stored on the PC. In this example, the MethodSCRIPT files are stored in the ScriptFiles directory. The code snippet below is used in the example to read the MethodSCRIPT from the file and in turn send it to the device.

```
#define MS_MAX_LINECHARS      128

int SendScriptFile(char* fileName)
{
      FILE *fp;
      char str[MS_MAX_LINECHARS+1]; //Including string termination(0)

      fp = fopen(fileName, "r");
      if (fp == NULL) {
            printf("Could not open file %s", fileName);
            return 0;
      }
// Reads a single line from the script file and sends it to the device.
      while (fgets(str, MS_MAX_LINECHARS, fp) != NULL)
      {
            WriteStr(&msComm, str);
      }
      fclose(fp);
      return 1;
}
```

3.4 Receiving measurement data packages

This example uses the *MSComm* library to receive and parse the data packages from a measurement. In order to read and parse the measurement data packages from the device, the ReceivePackage function from the *MSComm* library can be used. This function requires a reference to an initialized *MSComm* struct (*msComm*) and it returns the parsed data in the referenced MeasureData struct (*data*)

```
code = ReceivePackage(&msComm, &data);
```

3.5 Parsing the measurement data packages

Each measurement data package returned by the function *ReadBuf()* in *MSComm* library, can be parsed further to obtain the actual data values. For example, here is a set of data packages received from a Linear Sweep Voltammetry (LSV) measurement on a dummy cell with 10kOhm resistance.

```
e\n
M0000\n
Pda7F85F3Fu;ba48D503Dp,10,288\n
Pda7F9234Bu;ba4E2C324p,10,288\n
Pda806EC24u;baAE16C6Dp,10,288\n
Pda807B031u;baB360495p,10,288\n
*\n
\n
```

While parsing a measurement package, various identifiers are used to identify the type of package. For example, In the above sample,

1. ‘e’ is the confirmation of the “execute MethodSCRIPT” command.
2. ‘M’ marks the beginning of a measurement loop.
3. ‘P’ marks the beginning of a measurement data package.
4. “*\n” marks the end of a measurement loop.
5. “\n” marks the end of the MethodSCRIPT.

Most techniques return the data values Potential (set cell potential in V) and Current (measured current in A). The data values to be received from a measurement can be sent through ‘pck’ commands in the MethodSCRIPT.

In case of Electrochemical Impedance Spectroscopy (EIS) measurements, the following *variable types* can be sent with the MethodSCRIPT and received as measurement data values.

- Frequency (set frequency in Hz)
- Real part of complex Impedance (measured impedance Ohm)
- Imaginary part of complex Impedance (measured impedance in Ohm)

The following metadata values can also be obtained from the data packages, if present.

- CurrentStatus (OK, Underload, Overload, Overload warning)
- CurrentRange (the current range in use)
- Noise

3.5.1 Parsing the measurement data packages

Each measurement data package begins with the header ‘P’ and is terminated by a ‘\n’. The measurement data package can be split into data value packages based on the delimiter ‘;’. Each of these data value packages can then be parsed separately to get the actual data values.

The type of data in a data package is identified by its variable type:

- The potential readings are identified by the string “*da”*
- The current readings are identified by the string “*ba”*
- The frequency readings are identified by the string “*dc”*
- The real impedance readings are identified by the string “*cc”*
- The imaginary impedance readings are identified by the string “*cd”*

For example, in the sample package seen above, the *variable types* are
da7F85F3Fu - “*da” for p*otential reading and
ba48D503Dp,10,288 - “*ba” for* current reading.

The following 7 characters hold the 28-bit signed integer data value followed by one SI unit prefix character. The data value for the current reading (7 characters) from the above sample package is “*48D503D”* followed by the SI unit prefix ‘*p’* (pico, which is 1e-12 A).

After obtaining variable type and data values from the package, the metadata values can be parsed, if present.

3.5.2 Parsing the metadata values

The metadata values are separated based on the delimiter ‘,’ and each of the values is further parsed to get the actual value.

The first character of each metadata value metaData[0] identifies the type of metadata.

‘1’ - status
‘2’ - Current range index
‘4’ - Noise

The metadata status is a 1 character hexadecimal bit mask.

For example, in the above sample, the available metadata values for current data are,
10,288. The first metadata value is 10.

1 – metadata status – 0 indicates OK.

The metadata type current range is represented by a 2-digit hexadecimal value. If the first bit is high (0x80), it indicates a high-speed mode current range. The hexadecimal value can be converted to int to get the current range.

For example, in the above sample, the second metadata available is 288.
2 – indicates the type – current range
88 – indicates the hexadecimal value for current range index – 1mA. The first bit 8 implies that it is high speed mode current range.

3.5.3 Sample output

3.5.3.1 LSV

Here's a sample measurement data package from a LSV measurement on a dummy cell with 10kOhm resistance and its corresponding output.

```
Pda7F85F3Fu;ba4BA99F0p,10,288
```

Output:
E (V) = -4.999E-01
i (A) = -4.999E-01
Status : OK
CR : 1mA (High speed)

3.5.3.2 EIS

Here's a sample measurement data package from an EIS measurement on a dummy cell with 10 kOhm resistance and its corresponding output.

```
PdcDF5DFF4u;cc896D904m,10,287;cd82DB1A8u,10,287
```

Output:
Frequency(Hz): 100.0
Zreal(Ohm): 9885.956
Zimag(Ohm): 2.995
Status: OK
CR: 200uA (High speed)